NOTE: Choose the most suitable answer from the given four alternatives

1. If the equation \(-2x + y + z = l; x - 2y + z = m; x + y - 2z = n\) such that \(l+m+n = 0\), then the system has
   1) a non-zero unique solution  
   2) trivial solution  
   3) infinitely many solutions  
   4) No solution

2. The line \(4x + 2y = c\) is a tangent to the parabola \(y^2 = 16x\) then \(c\) is
   1) -1  
   2) -2  
   3) 4  
   4) -4

3. The distance between the foci of the ellipse \(9x^2 + 5y^2 = 180\) is
   1) 4  
   2) 6  
   3) 8  
   4) 2

4. The asymptotes of the hyperbola \(36y^2 - 25x^2 + 900 = 0\) are
   1) \(y = \pm \frac{5}{6} x\)  
   2) \(y = \pm \frac{6}{5} x\)  
   3) \(y = \pm \frac{25}{36} x\)  
   4) \(y = \pm \frac{36}{25} x\)

5. The equation of the normal to the curve \(\theta = \frac{1}{t}\) at the point \((-3, \frac{1}{3})\) is
   1) \(3 \theta = 27t - 80\)  
   2) \(5 \theta = 27t - 80\)  
   3) \(3 \theta = 27t + 80\)  
   4) \(\theta = \frac{1}{t}\)

6. The curve \(a^2 y^2 = x^2 (a^2 - x^2)\) has
   1) a loop between \(x = a\) and \(x = -a\)  
   2) two loops between \(x = a\) and \(x = 0; \ x = 0\) and \(x = a\)  
   3) two loops between \(x = 0\) and \(x = a\)  
   4) no loop

7. The area bounded by the curve \(x = f(y)\), \(y\)-axis and the lines \(y=c\) and \(y=d\) is rotated about \(y\)-axis. Then the volume of the solid is
   1) \(\pi \int x^2 \, dy\)  
   2) \(\pi \int x^2 \, dx\)  
   3) \(\pi \int y^2 \, dx\)  
   4) \(\pi \int y^2 \, dy\)

8. The differential equation corresponding to \(xy = c^2\) where \(c\) is an arbitrary constant, is
   1) \(xy'' + x = 0\)  
   2) \(y'' = 0\)  
   3) \(xy' + y = 0\)  
   4) \(xy'' - x = 0\)

9. In congruence modulo5, \((x \in \mathbb{Z} / x = 5k + 2, k \in \mathbb{Z})\) represents
   1) \([0]\)  
   2) \([5]\)  
   3) \([7]\)  
   4) \([2]\)

10. If \(X\) is a continuous random variable then \(P(X > a) = \int 1 - P(X > a)\)
   1) 1  
   2) 1 - \(P(X > a)\)  
   3) \(P(X > a)\)  
   4) \(1 - P(X > a - 1)\)

11. If the volume of an expanding cube is increasing at the rate of \(4\) cm\(^3\)/sec then the rate of change of surface area when the volume of the cube is 8 cubic cm is
   1) \(8\) cm\(^2\)/sec  
   2) \(16\) cm\(^2\)/sec  
   3) \(2\) cm\(^2\)/sec  
   4) \(4\) cm\(^2\)/sec

12. The order of \(i\) in the multiplicative group of \(4\)th roots of unity is
   1) 4  
   2) 3  
   3) 2  
   4) 1

13. The curve \(y^2(x-2) = x^2(1+x^2)\) has
   1) an asymptote parallel to \(x\)-axis  
   2) an asymptote parallel to \(y\)-axis  
   3) asymptotes parallel to both axes  
   4) no asymptotes

14. The value of \(\int \frac{\cos \frac{\pi}{2}}{x + \sin \frac{\pi}{2}} \, dx\) is
   1) \(\frac{\pi}{2}\)  
   2) \(\frac{\pi}{4}\)  
   3) 0  
   4) \(\pi\)

15. The value of \(\int \frac{\sin x - \cos x}{\sin x \cos x} \, dx\) is
   1) \(\frac{\pi}{2}\)  
   2) 0  
   3) \(\frac{\pi}{4}\)  
   4) \(\pi\)

16. The rank of the matrix \(\begin{bmatrix} 1 & -1 & 2 \\ 2 & -2 & 4 \\ 4 & -4 & 8 \end{bmatrix}\) is
   1) 1  
   2) 2  
   3) 3  
   4) 4

17. If \(I\) is unit matrix of order \(n\), where \(k \neq 0\) is a constant, then \(\text{adj}(kI) = \)
   1) \(k^0 \text{adj} I\)  
   2) \(k \text{adj} I\)  
   3) \(k^2 \text{adj} I\)  
   4) \(k^{n-1} \text{adj} I\)
18. The quadratic equation whose roots are $\pm i \sqrt{7}$ is
1) $x^2 + 7 = 0$
2) $2x^2 - 7 = 0$
3) $x^2 + x - 7 = 0$
4) $x^2 - x - 7 = 0$

19. If $\vec{a} + \vec{b} + \vec{c} = 0$, $|\vec{a}| = 3$, $|\vec{b}| = 4$, $|\vec{c}| = 5$, then the angle between $\vec{a}$ and $\vec{b}$ is
1) $\pi / 6$
2) $2\pi / 3$
3) $5\pi / 3$
4) $\pi / 2$

20. If $\vec{a} \times (\vec{b} \times \vec{c}) + \vec{b} \times (\vec{c} \times \vec{a}) + \vec{c} \times (\vec{a} \times \vec{b}) = \vec{x} \times \vec{y}$ then
1) $\vec{x} = 0$
2) $\vec{y} = 0$
3) $\vec{x}$ and $\vec{y}$ are parallel
4) $\vec{x} = 0$ (or) $\vec{y} = 0$ (or) $\vec{x}$ and $\vec{y}$ are parallel

21. The curved surface area of a sphere of radius 5, intercepted between two parallel planes of distance 2 and 4 from the centre is
1) $20\pi$
2) $40\pi$
3) $10\pi$
4) $30\pi$

22. The differential equation of all non-vertical lines in a plane is
1) $\frac{dy}{dx} = 0$
2) $\frac{d^2y}{dx^2} = 0$
3) $\frac{dy}{dx} = m$
4) $\frac{d^2y}{dx^2} = m$

23. The degree of the differential equation $c = \left[ \left( \frac{dy}{dx} \right)^ {3/5} \right]^{1/3}$, where $c$ is a constant is
1) 1
2) 3
3) 2
4) 2

24. The differential equation satisfied by all the straight lines in $xy$-plane is
1) $\frac{dy}{dx}$ is a constant
2) $\frac{d^2y}{dx^2} = 0$
3) $y + \frac{dy}{dx} = 0$
4) $\frac{d^2y}{dx^2} + y = 0$

25. Which of the following are statements?
(i) May God bless you
(ii) Rose is a flower
(iii) Milk is white
(iv) 1 is a prime number
1) (i), (ii), (iii)
2) (i), (ii), (iv)
3) (i), (ii), (iii), (iv)
4) (ii), (iii), (iv)

26. In the homogeneous system $\rho(A) < \text{the number of unknowns then the system has}$
1) only trivial solution
2) trivial solution and infinitely many non-trivial solutions
3) only non-trivial solutions
4) no solution

27. The non-parametric vector equation of a plane passing through the points whose position vectors are $\vec{a}$, $\vec{b}$ and parallel to $\vec{v}$ is
1) $[\vec{r} - \vec{a} \cdot \vec{b} - \vec{a} \cdot \vec{v}] = 0$
2) $[\vec{r} \cdot \vec{b} - \vec{a} \cdot \vec{v}] = 0$
3) $[\vec{a} \cdot \vec{b} \cdot \vec{v}] = 0$
4) $[\vec{v} \cdot \vec{a} \cdot \vec{b}] = 0$

28. If a line makes $45^\circ$, $60^\circ$ with positive direction of axes $x$ and $y$ then the angle it makes with the $z$-axis is
1) $30^\circ$
2) $90^\circ$
3) $45^\circ$
4) $60^\circ$

29. If $\vec{a}$, $\vec{b}$, $\vec{c}$ are non-coplanar and $[\vec{a} \times \vec{b} \cdot \vec{c} \times \vec{a}] = [\vec{a} \times \vec{b} \cdot \vec{c} \times \vec{a}]$, then $[\vec{a} \cdot \vec{b} \cdot \vec{c}]$ is
1) 2
2) 3
3) 1
4) 0

30. If a compound statement is made up of three simple statements, then the number of rows in the truth table is
1) 8
2) 6
3) 4
4) 2

31. The point of inflexion of the curve $y = x^4$ is at
1) $x = 0$
2) $x = 3$
3) $x = 12$
4) nowhere

32. A box contains 6 red balls and 4 white balls. If 3 balls are drawn at random, the probability of getting 2 white balls without replacement is
1) $\frac{1}{20}$
2) $\frac{18}{125}$
3) $\frac{4}{25}$
4) $\frac{3}{10}$

33. For a Poisson distribution with parameter $\lambda = 0.25$ the value of the 2nd moment about the origin is
1) 0.25
2) 0.3125
3) 0.0625
4) 0.025

34. If the mean and standard deviation of a binomial distribution are 12 and 2. Then the value of its parameter $p$ is
1) $\frac{1}{2}$
2) $\frac{1}{3}$
3) $\frac{2}{3}$
4) $\frac{1}{4}$

35. The equation of the plane passing through the point $(2, 1, -1)$ and the line of intersection of the planes $r.(i + 3j - k) = 0$ and $r.(j + 2k) = 0$ is
1) $x + 4y - z = 0$
2) $x + 9y + 11z = 0$
3) $2x + y - z + 5 = 0$
4) $2x - y + z = 0$
36. If \( x^2 + y^2 = 1 \), then the value of \( \frac{1 + x + iy}{1 + x - iy} \) is

1) \( x - iy \) 2) \( 2x \) 3) \(-2iy\) 4) \( x + iy \)

37. If the amplitude of a complex number is \( \frac{\pi}{2} \), then the number is

1) purely imaginary 2) purely real 3) 0 4) neither real nor imaginary

38. Polynomial equation \( P(x) = 0 \) admits conjugate pairs of imaginary roots only if the coefficients are

1) imaginary 2) complex 3) real 4) either real (or) complex

39. The condition that the line \( lx + my + n = 0 \) may be a tangent to the rectangular hyperbola \( xy = c^2 \) is

1) \( a^2i^2 + b^2m^2 = n^2 \) 2) \( am^2 = 1 \) 3) \( a^2i^2 - b^2m^2 = n^2 \) 4) \( 4c^2bn = n^2 \)

40. If a real valued differentiable function \( y = f(x) \) defined on an open interval \( I \) is increasing then

1) \( \frac{dy}{dx} > 0 \) 2) \( \frac{dy}{dx} \leq 0 \) 3) \( \frac{dy}{dx} < 0 \) 4) \( \frac{dy}{dx} \geq 0 \)

SECTION- B

NOTE: Answer any ten questions. Question No.55 is compulsory and choose nine from remaining questions.

41. If \( A = \begin{bmatrix} -1 & 2 \\ 1 & -4 \end{bmatrix} \) and verify that the result \( (\text{adj}\ A) = (\text{adj}\ A)A = [A] \cdot I_2 \).

42. State and prove reversal law for inverses of matrices.

43. With usual notations prove that \( \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \).

44. Show that diameter of a sphere subtends a right angle at a point on the surface.

45. \( P \) represents the variable complex number \( z \). Find the locus of \( P \), if \( \text{Im}(z^2) = 4 \).

46. The tangent at any point of the rectangular hyperbola \( xy = c^2 \) makes intercepts \( a, b \) and the normal at the point makes intercepts \( p, q \) on the axes. Prove that \( ap+bq = 0 \).

47. Find the equations of the tangent and normal to the curve \( y = x^2 - x - 2 \) at the point \((-1, -2)\).

48. Find the intervals of concavity and the points of inflection of the function \( f(x) = (x - 1)^3 \).

49. If \( V = ze^{ax+ib} \) and \( z \) is a homogeneous function of degree \( n \) in \( x \) and \( y \) prove that

\[
\frac{\partial V}{\partial x} + \frac{\partial V}{\partial y} = (ax + by + n)V.
\]

50. Evaluate \( \int_0^\frac{\pi}{2} \sin^3 x \, dx \) and try.

51. i) Solve. \((D^2+1)y=0\).

ii) Form the differential equations for the given function \( y = ax^2 + bx + c \) by eliminating arbitrary constants \( \{a, b\} \).

52. Show that \((p \lor q)\implies(p \lor q)\) is a tautology.

53. 20% of the bolts produced in a factory are found to be defective. Find the probability that in a sample of 10 bolts chosen at random exactly 2 will be defective using

(i) Binomial distribution  
(ii) Poisson distribution. \( \{e^2 = 0.1353\} \).

54. A discrete random variable \( X \) has the following probability distributions.

<table>
<thead>
<tr>
<th>( X )</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P(X=x) )</td>
<td>a</td>
<td>3a</td>
<td>5a</td>
<td>7a</td>
<td>9a</td>
<td>11a</td>
<td>13a</td>
<td>15a</td>
<td>17a</td>
</tr>
</tbody>
</table>

(i) Find the value of \( a \)  
(ii) Find \( P(x<3) \)  
(iii) Find \( P(3<x<7) \)

55. a) Find the least positive integer \( n \) such that \( \frac{1+i}{1-i} = 1 \).

b) Show that \( (R - \{0\}, .) \) is an infinite abelian group. Here . denotes usual multiplication

(OR)
56. Discuss the solutions of the system of equations for all values of $\lambda$. 
\[ \begin{align*} 
    x+y+z &= 2, \\
    2x+y-2z &= 2, \\
    x+y+4z &= 2. 
\end{align*} \]

57. Prove that $\cos(A-B) = \cos A \cos B + \sin A \sin B$.

58. Find the vector and Cartesian equation to the plane through the point (-1, 3, 2) and perpendicular to the planes $x+2y+2z=5$ and $3x+y+2z=8$.

59. If $\alpha$ and $\beta$ are the roots of the equation $x^2 - 2x + 4 = 0$, then prove that $\alpha^3 - \beta^3 = i2^{n+1} \sin \frac{n\pi}{3}$ and deduct $\alpha^2 - \beta^2$.

60. Assume that water issuing from the end of a horizontal pipe, 7.5m above the ground, describes a parabolic path. The vertex of the parabolic path is at the end of the pipe. At a position 2.5m below the line of the pipe, the flow of water has curved outward 3m beyond the vertical line through the end of the pipe. How far beyond this vertical line will the water strike the ground?

61. A kho-kho player in a practice session while running realises that the sum of the distances from the two kho-kho poles from him is always 8m. Find the equation of the path traced by him if the distance between the poles is 6m.

62. Show that the line $x-y+4=0$ is a tangent to the ellipse $x^2+3y^2=12$. Find the co-ordinates of the point of contact.

63. Evaluate $\lim_{x \to 0} \left( x \sin \left( \frac{\pi}{2} \right) \right)$.

64. Use differentials to find an approximate value for the given number $y = \sqrt{1.02} + \sqrt{1.02}$.

65. Find the area of region enclosed by $y^2 = x$ and $y = x-2$.

66. Solve: $(D^2 - 2D + 1)y = e^{x^2} - \cos 3x$.

67. A cup of coffee at temperature 100°C is placed in a room whose temperature is 15°C and it cools to 60°C in 5 minutes. Find its temperature after a further interval of 5 minutes.

68. Show that the set $G$ of all matrices of the form $\begin{pmatrix} x & x \\ x & x \end{pmatrix}$, where $x \in R - \{0\}$, is a group under matrix multiplication.

69. The air pressure in a randomly selected tyre put on a certain model new car is normally distributed with Mean value 31 psi and standard deviation 0.2 psi.

   (i) What is the probability that the pressure for a randomly selected tyre

   (a) between 30.5 and 31.5 psi   (b) between 30 and 32 psi.

   (ii) What is the probability that the pressure for a randomly selected tyre exceeds 30.5 psi

   [ Area table: P(0<z<2.5) = 0.4938 ].

70. a) At noon, ship A is 100 km west of ship B. Ship A is sailing east at 35 km/hr and ship B is sailing north at 25 km/hr. How fast is the distance between the ships changing at 4.00 p.m.?

   (OR)

   b) Derive the formula for the volume of a right circular cone with radius ‘r’ and height ‘h’
1. \( \frac{\partial y}{\partial x} = \frac{\partial x}{\partial y} \) 
2. \( \frac{\partial y}{\partial x} \) 
3. \( \frac{\partial y}{\partial x} \) 
4. \( \frac{\partial y}{\partial x} \) 
5. \( \frac{\partial y}{\partial x} \) 
6. \( \frac{\partial y}{\partial x} \) 
7. \( \frac{\partial y}{\partial x} \) 
8. \( \frac{\partial y}{\partial x} \) 
9. \( \frac{\partial y}{\partial x} \) 
10. \( \frac{\partial y}{\partial x} \) 
11. \( \frac{\partial y}{\partial x} \) 
12. \( \frac{\partial y}{\partial x} \) 
13. \( \frac{\partial y}{\partial x} \) 
14. \( \frac{\partial y}{\partial x} \) 
15. \( \frac{\partial y}{\partial x} \)
16. \( a^2 + b^2 = c^2 \) if \( a, b, c \) are sides of a right triangle.

17. \( 1 \times n \times m = n \times m \) since order is immaterial.

18. \( 2 \times 3 = 6 \times 1 \) when order is immaterial.

19. \( 1 + 2 = 2 + 1 \) when order is immaterial.

20. \( \frac{1}{2} \times 3 = \frac{3}{2} \times 1 \) when order is immaterial.

21. \( 1 + 2 = 2 + 1 \) when order is immaterial.

22. \( 1 \times 2 = 2 \times 1 \) when order is immaterial.

23. \( 2^2 = 4 \) when order is immaterial.

24. \( 3^2 = 9 \) when order is immaterial.

25. \( 4^2 = 16 \) when order is immaterial.

26. \( 5^2 = 25 \) when order is immaterial.

27. \( \int x^2 \cos \left( \frac{x}{2} \right) \, dx = 2 \cos \left( \frac{x}{2} \right) \sin \left( \frac{x}{2} \right) + C \) when order is immaterial.

28. \( \int \frac{dy}{dx} \, dx = \left[ a + b \right] \) when order is immaterial.

29. \( c = \left( \frac{d^2 y}{dx^2} \right)^{2/3} \) when order is immaterial.
33. \[ \frac{dy}{dx} = f(x) \] 2) \[ \frac{d^2 y}{dx^2} = 0 \] 3) \[ y + \frac{dy}{dx} = 0 \] 4) \[ \frac{d^2 y}{dx^2} + y = 0 \]

34. \[ y = \frac{1}{x} \] 6. \[ p(x) = \frac{1}{x^2} + \frac{b}{x} + c \]

35. \[ \frac{2}{3} \]

36. \[ \frac{1}{2} \]

37. \[ \frac{1}{3} \]

38. \[ \frac{2}{4} \]

39. \[ P(X=0) = \frac{1}{2} \]

40. \[ X \]

41. \[ \frac{1}{2} \]

42. \[ \frac{1}{4} \]

43. \[ \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \]

44. \[ \frac{1}{2} \]

45. \[ P \]

46. \[ q \]

47. \[ \frac{1}{2} \]

48. \[ f(x) = (x-1)^2 \]

49. \[ V = ze^{ax+by} \]

50. \[ \frac{3}{4} \]

51. \[ y \]

52. \[ p \]

53. \[ 0.1353 \]
(a) \( P(X=x) = \begin{cases} \frac{1}{3} & \text{if } x=1, 3, 2 \\ 0 & \text{otherwise} \end{cases} \)

\[ P(0<z<2.5) = 0.4938 \]

(b) \( R \in [0, 1) \) for the beta distribution with parameters \( \alpha \) and \( \beta \).

\[ x^2 - 2x + 4 = 0 \]

\[ \frac{\tan x}{\sin x} = \beta \sin x \]

\[ x+y+z = 2 \]

\[ 1, 3, 2 \]

\[ 5x + 2y + 2z = 8 \]

\[ 15x + 3y + 2z = 8 \]

\[ 2x + y + 4z = 0 \]

\[ \lim_{x \to 0} \frac{1}{x^2} = 0 \]

\[ \int_a^b f(x) \, dx \]

\[ \frac{\tan x}{\sin x} = \beta \sin x \]

\[ x^2 - 2x + 4 = 0 \]

\[ \frac{\tan x}{\sin x} = \beta \sin x \]

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\[ 1, 3, 2 \]

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\[ 1, 3, 2 \]

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\[ 15x + 3y + 2z = 8 \]

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